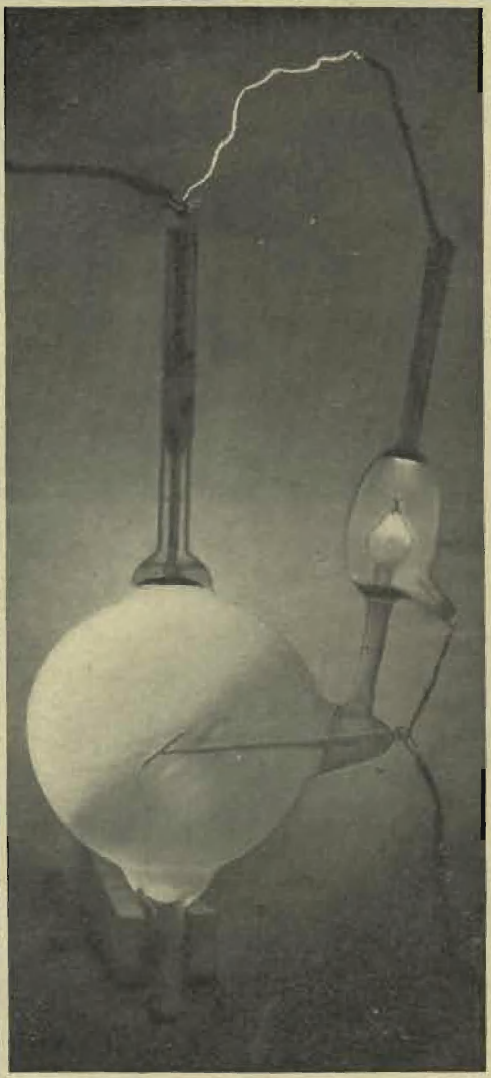
PATENT NO. 594056 NOVEMBER TWENTY THIRD 1897



JOHN SCOTT MEDAL FRANKLIN INSTITUTE 1898

QUEEN SELF-REGULATING X-RAY TUBE

QUEEN & CO., INC., PHILADELPHIA & NEW YORK

★ ★ "ESPECIALLY INGENIOUS" ★ ★

Prof. Dr. W. C. Röntgen.

H. LYMAN SAYEN

★ ★ "MOST SATISFACTORY" ★ ★

Kelvin

QUEEN

SELF-REGULATING

X-RAY TUBE

Queen & Co., Inc.

OPTICAL AND SCIENTIFIC INSTRUMENT WORKS

1010 CHESTNUT STREET

Philadelphia

New York Branch
59 Fifth Avenue

THE QUEEN SELF-REGULATING X-RAY TUBE was placed on the market in 1897. Since then it has been adopted by nearly all the leading experts of the country. It gives the operator the power to control and regulate the vacuum with which he works, and he can thereby vary the penetrating power and other qualities of the X-Ray to suit his varying requirements. The ability to do this not only facilitates work of an ordinary character presenting no unusual difficulities but is essential when difficult work is in hand, such as locating foreign bodies in deep seated tissue or distinguishing between affected and normal tissues which do not differ greatly in density. Consequently, we feel justified in claiming that our tube is an indispensible part of the outfit of a radiographer who would be in position to render to the surgeon all the aid his science is capable of furnishing.

The illustration on the front cover is made from a tube in operation.

Brief Historical Sketch.

THE MOST important considerations in the design and manufacture of X-Ray apparatus are those influenced by the value of the apparatus to physicians and hospitals. An induction coil properly designed and constructed will, with any reasonable care, last indefinitely. The manipulation of the dry plate is the same as in ordinary photography, requiring only a knowledge of developing, fixing, etc. The real difficulties are met with only in the operation of the high vacuum tube in which so many factors are to be considered in achieving satisfactory results.

In order that the operation and advantages of our self-regulating X-Ray tube be well understood, it seems that a brief "resumé" of the work which led up to professor Röntgen's discovery and the subsequent development of X-Ray tubes, would not be out of place.

Radiant Matter

Faraday was the first to conceive of matter in the so-called "radiant state." He defined it thus: "If we can conceive a change as far beyond vaporization as that is above fluidity and then take into account also the proportional increased extent of alteration as the changes rise, we shall perhaps, if we can form any conception at all, not fall far short of radiant matter and as in the last conversion many qualities were lost, so here many more would disappear." Sir William Crookes in 1879 made public his highly interesting experiments with tubes carried to such a degree of exhaustion that the gases therein were in the so-called radiant state. He states it as his opinion that the quantity of matter left in a tube exhausted to this degree is about one millionth part of what it was at atmospheric pressure. Recent very careful measurements by Brush entirely confirm this opinion.

Theory of Gases

In a brief introductory note on the general theory of gases Crookes in his papers calls attention to the fact that gases are conceived of an almost infinite number of small particles or molecules which are constantly moving in every direction with velocities of all conceivable magnitudes. Owing to the great number of molecules it is impossible for them to move an appreciable distance before they collide with one of their fellows. If the pressure of the gas be diminished the distance which the molecule can move is proportionately increased. This average distance is called the mean free path of the molecule. If the pressure be so decreased that the mean free path is comparable with the dimensions of the containing vessel, the matter is then in the so-called "radiant state" and the molecules are free to bound in straight lines forwards and backwards across the tubes. These molecules radiate from a negatively excited pole or cathode with enormous velocity producing

Cathode Rays

many phenomena wherever they strike. The streams of molecules radiating from the cathode are called cathode rays. Crookes constructed a number of very ingenious tubes to show the

novel and characteristic properties of radiant matter, and he assigned the following properties to it:

Radiant matter exerts a powerful phosphorogenic action where it strikes.

It proceeds in straight lines.

When intercepted by solid matter it casts a shadow.

It exerts strong mechanical action where it strikes.

Radiant matter produces heat when its motion is arrested.

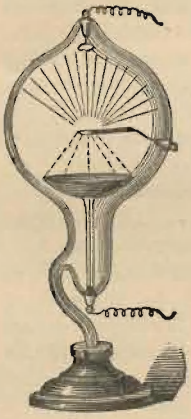


FIG. 1.

Hot Platinum Tube

To show this last property he made a small tube identical with the one shown in Fig. I. It consists of a thin platinum plate placed in the focus of a converging stream of radiant matter. A weak current from the coil is more than sufficient to heat the platinum red hot. Had Crookes gone a little further in his experiment he would

FIG. 2.

X-Rays

have found that not only heat and phosphorescence manifest themselves but that these molecular collisions give rise to a disturbance of such a character as to excite phosphorescence not only inside the tube but outside of it. There would also have been demonstrated that these disturbances radiate in straight lines, suffering no refraction,

deflection, or other of the phenomena incident to ordinary light, and that all substances are more or less transparent to them.

Whether the X-Rays are the result of the enormously high temperature produced by the impact of the molecules, whether they are due to oscillation set up in the charges, in the discharging atoms, or whether they arise from an entirely different cause is matter of speculation.

The original tube used by Röntgen was similar in construction to that shown in Fig. 2. In this the bombardment is on the glass at the spherical end of the tube. The efficient X-Rays resulting are few, because it is impossible to bombard the glass very hard without cracking or melting it; a considerable portion of the rays are absorbed in traveling through the thick glass at the end of the tube; and, to get a sharp picture, the

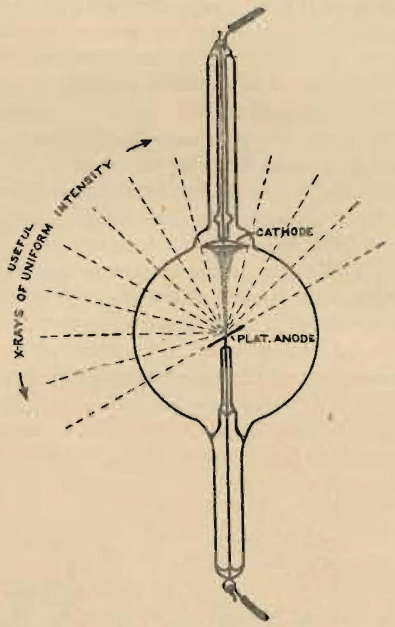


FIG. 3.

light must be considerably cut off by a diaphragm. Practically, all forms of tubes were tried by the early investigators. The one finally found efficient was discovered by Kings College, London, in 1896. It was the Crookes hot platinum tube. Dr. Arthur W. Goodspeed, of the University of Pennsylvania, independently made the same discovery April 6th of the same year. This is the fundamental form of tube used by various makers throughout the world to-day, though with considerable modifications as to detail arrangement.

Essential Features of an X-Ray Tube

The essential in the design of an X-Ray tube includes a cathode of such shape as to focus the cathode rays on a plate of dense metal, such as platinum, which either is the anode or is placed near to it.

Fig. 3 is the illustration of such a tube. The cathode rays represented by the shaded area focus at a point on the anode, and at this point the X-Rays originate, and from it radiate in every direction in straight lines as light rays do from a source of light. They are represented by broken lines. As platinum is not transparent to them, they are found only on one side of the plane of the platinum, and are practically of equal intensity throughout that zone. If the platinum plate were absolutely true and polished such would be strictly the case. As it is, in practice the rays are of equal intensity down to about ten degrees from the plane of the platinum. The platinum must not be considered as a reflector, but as a source of illumination.

Importance of Correct Degree of Exhaustion

Numerous early investigators discovered, however, that even with well designed tubes there were critical conditions of exhaustion that were essential for the production of good results, and that the proper degree of exhaustion was often difficult to produce and always exceedingly difficult to maintain. The tubes exhibited a constant tendency to change in this respect; a permanent rise in vacuum resulted from their continued use, and a temporary fall always followed the heating, due to the discharge of a large current through them. These changes were so prejudicial to good work that numerous devices have been suggested and tried to regulate the vacuum. Following an arrangement used by Crookes many makers used a small side bulb containing caustic potash, which, when heated, gave off vapor and lowered the vacuum. This proved difficult to manipulate, as it was almost impossible to apply just the right quantity of heat. As an improvement to it it was suggested that the bulb might be surrounded by a coil of wire, to be heated by a battery, and its temperature controlled by a rheostat (Fig. 4).

Early Attempts to Control Degree of Exhaustion

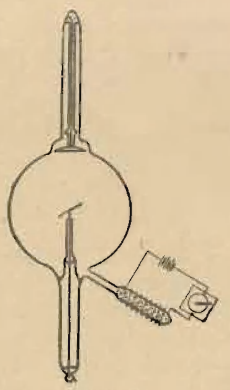


FIG. 4.

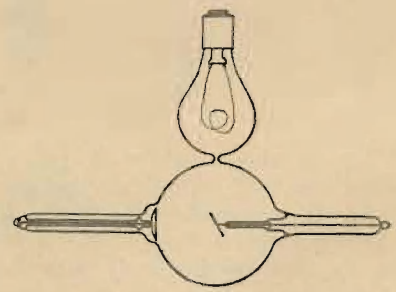


FIG. 5.

Dr. Morton, of New York, suggested the addition of an incandescent lamp bulb in an auxiliary tube (Fig. 5). The filament of the incandescent lamp bulb acted in much the same way as the wire in the last tube

described; the current flowing through it was controlled by a rheostat, and the gases given off by it lowered the vacuum of the tube.

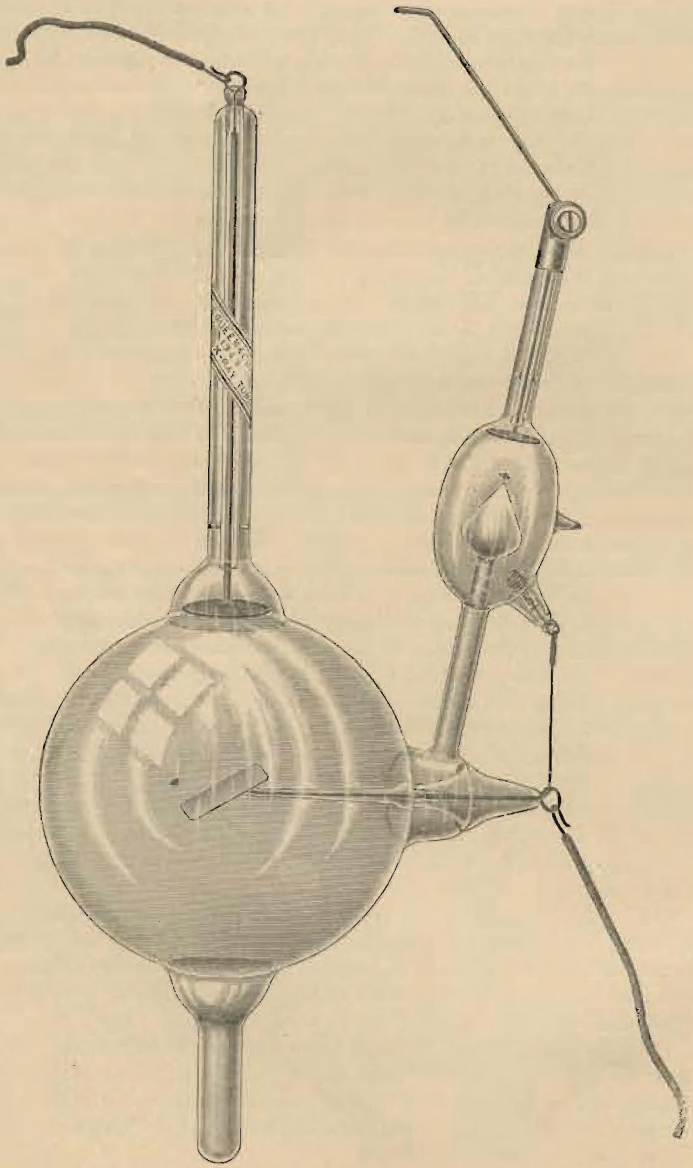
One of the most ingenious devices was that put on the market by Siemens & Halske, of Berlin. This tube offers the possibility of raising as well as lowering the vacuum. Taking advantage of the fact that vapor of phosphorus under the influence of an electric current tends to solidify and attach itself to the walls of the tubes, they provide an auxiliary tube containing this vapor and provided with an electrode. When the vacuum is too low this terminal and the cathode are connected and the current discharged through it until corrected. When the vacuum is too high the auxiliary bulb is heated by a lamp to reduce it.

Reasons for Failure of These Methods

All of these devices lacked success from the very fact that the vacuum is in too fickle a state for the human hand to control. To produce good X-Rays it may vary over only very small limits and is very easily influenced by changes of temperature. In fact, a high vacuum tube subjected to the discharge of a large induction coil may be said to be in a state of unstable equilibrium, and when once started to change in either direction will continue with a continually accelerating speed. In order that the degree of exhaustion should remain constant it is essential that the temperature of the tube remain constant. This means that the heat generated by the cathode rays striking the platinum and walls must be dissipated into the surrounding atmosphere as rapidly as it is generated. If this is not done the tube will grow either hotter or colder, and the vacuum, as a result, become either lower or higher. More than this, the resistance of the tube to the flow of the electric current varies with the degree of exhaustion, increasing as the height of vacuum increases, and decreasing as the vacuum decreases. Hence, a tube which is growing hotter is also becoming a better and better conductor, more current is flowing through it, and the heat is generated more and more rapidly. On the other hand, the tube cooling is becoming a poorer and poorer conductor, and a gradually decreasing amount of heat is generated inside of it. To get the amount of current the induction coil gives nicely proportioned, so that the particular tube which is being used will give off heat just as rapidly as it heats up is the most difficult problem which has confronted the users of non-self-regulating tubes.

These peculiarities of the high vacuum tube have made it evident that a regulating device designed so that it must be set in action by the operator is foredoomed to be at best but a partial success, and cannot be even that, except in the hands of an operator of unusual skill and long experience, no matter how ingenious it may be.

With this introduction we pass on to the description of the methods which we have employed to overcome these difficulties, making use of the two physical properties of high vacuum tubes above referred to—the increase of resistance with the increasing height of the vacuum, and the heating power of the cathode rays.



QUEEN SELF-REGULATING X-RAY TUBE.

QUEEN SELF-REGULATING X-RAY TUBE.

Theory and Operation

A reference to the illustration will make the operation of the tube clear. A small bulb containing a chemical which gives off vapor when heated and re-absorbs it when it cools, is directly connected to the main tube, and is surrounded by an auxiliary tube, which is exhausted to a low Crookes' vacuum. In the auxiliary tube the cathode is opposite to the above-mentioned bulb, so that any discharge through it will heat the bulb by the bombardment of the cathode rays. This cathode is connected to an adjustable spark point, the end of which may be swung to any desired distance from the cathode of the main tube. The anode of the small tube is directly connected to the anode of the main tube. The coil is connected as usual to the main tube, which has been exhausted to a very high vacuum, and consequently has a high resistance equal to ten inches of air or more. When it is put in operation the vacuum of the main tube being high, and consequently having high resistance, the current takes the path of least resistance by the spark point and the auxiliary tube, which, being a low Crookes' vacuum, has a very small resistance, and heats the chemical in the small bulb, thereby releasing the vapor which it contains in state of absorption and driving it into the main tube. This will continue for a few seconds until a sufficient amount of vapor has been driven into the main tube to permit the current to go through it, which will begin to take place when the vacuum has been reduced until the resistance of the main tube is brought down to that of the spark gap plus the small resistance of the auxiliary bulb. After this only an occasional spark will jump across the gap to counteract the tendency of the chemical as its bulb cools to re-absorb vapor and raise the resistance of the main tube. The tube is thus maintained at a constant vacuum while running. When the current is stopped the chemical cools off and re-absorbs vapor and the tube returns to its starting condition of high vacuum.

Adjustment of the Vacuum

It will be evident from the above that the height of the vacuum at which the tube runs will depend on the resistance of the circuit through the auxiliary bulb; in other words, on the length of the spark gap. The tube may be set to run at high vacuum by placing the spark point at a considerable distance from the cathode terminal of the main tube, or to run low by placing it near. The adjustability of the vacuum is of the utmost importance, as the penetrating power, photographic effect and ability to brilliantly light a fluorescing screen all depend on the degree of exhaustion; and that degree of vacuum which is best for one operation is not for another. With the Queen Self-Regulating X-Ray Tube the vacuum may be made so high that it is impossible to force any current through it, or so low that the current will go through the tube rather than jump over a parallel spark gap of one-half inch, a range of vacuum that includes all possible X-Ray work.

Capacity to Carry Large Currents

A non-self-regulating X-Ray tube is limited in its current carrying capacity because the unavoidable heating due to a large current temporarily liberates vapor from the electrodes and the walls and reduces the degree of exhaustion below the proper working point. This cannot be avoided by exhausting such tubes to a very high vacuum as they will then be too high in resistance to allow current to pass and an attempt to force them with a large coil invariably results in puncture. With our tubes the capacity to carry large currents is very greatly increased as the initial very high vacuum of the main bulb is reduced to the working point by the regulating tube without danger of puncture. As the current is increased and the walls and platinum heat up and release vapor the potash bulb cools off and re-absorbs that which was driven off from it. Thus the amount of current which our tubes may be made to carry depends on the initial exhaustion and appears to be limited only by the melting point of the platinum. This is a very important point, as the length of exposure necessary to make a radiograph is proportional inversely to the current going through the tube.

Details of Construction

We have been continuously experimenting with a view to improving the general efficiency and design. The form of tube represented by the illustration embodies the latest results of our extensive experience in X-Ray work. The main bulb is about 4½ inches in diameter, and is blown from the best selected German glass tubing. A bulb of such a size has to withstand an atmospheric pressure of over 700 pounds, and it may be surprising to know that the glass where penetrated by the X-Rays is less than $\frac{1}{32}$ of an inch thick. Being more or less opaque to the rays, it is of importance that there should be as little glass to intercept them as is consistent with substantial construction.

We have adopted a large diameter bulb because it heats less, being so remote from the platinum, and, what is of more importance, it distributes the inevitable but gradual deposit of aluminum over a large area. With a small bulb this deposit being concentrated is a conductor of electricity and causes a decrease of efficiency in the action of the tube.

The cathode is of pure hard hammered aluminum, accurately ground and polished to the proper curve to concentrate the cathode rays on a small surface of the platinum. This gives a small source of X-Rays and insures radiographs of sharp definition and clearness. The cathode terminals of both the main tube and regulator are extended and protected by double thickness of glass, making puncturing almost an impossibility. The anode is of heavy platinum foil $\frac{1}{2}$ inch x $\frac{7}{8}$ inch. Its thickness and size make it able to stand considerable energy without being melted through, and it is set at an angle of about 60 degrees to the path of the cathode rays, which increases the accuracy of definition and efficiency without materially diminishing the field of view. The lower part of the main bulb has an extension of strong glass, remote from the leading in wires, for clamping the tube. The bulb containing the regulating chemical is made conical, the point towards the cathode in order that there shall be an even distribution of the heat generated. The point of the bulb is protected by a small platinum shield.

Directions for Using the Queen Self-Regulating X-Ray Tube.

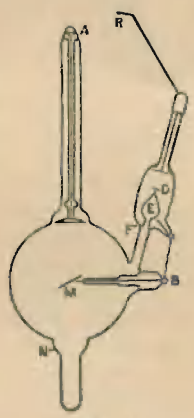


Fig. 6.

Before attempting to use the tube the operator should have secured a perfect working knowledge of the apparatus which is to produce the current to energize it. It is essential that the operator be able to produce all the variations in frequency and volume that his coil is capable of before he attempts to run a tube. Whenever the tube does not work properly he should disconnect it and test the working of his coil and see that it is performing properly.

Connections

Connect the wire from the negative terminal of the induction coil to the cathode terminal A, and the positive terminal of the induction coil to the anode B.

Should the polarity of the coil terminals not be known, the appearance of the tube must guide the operator, and he should so familiarize himself with it that he can tell at a glance whether the tube is running rightly or wrongly. It is difficult to describe satisfactorily the appearance of an X-Ray tube running either rightly or wrongly. We believe, however, that by careful attention to the following points of difference even an inexperienced operator will be able to distinguish between them.

(1) A tube running rightly with a discharge passing through the auxiliary tube will show a shadow of the protective platinum tip D on the top of the potash bulb E, and a shadow of the latter at F. This condition is shown in the reproduction on the front cover, which shows a tube in operation. With a current going in the wrong direction through the auxiliary tube it will light up, but neither of the above mentioned shadows will show.

(2) When the main bulb lights up it should have the appearance of the reproduction on the front cover. The upper half of the tube should fluoresce brilliantly green and uniformly, while the lower part is relatively dark. The boundary between the dark and light portion is the plane of the platinum anode. The current going in the wrong direction through the tube lights it up all over, but not uniformly.

(3) When the tube is running rightly a shadow of the anode M is cast by the cathode rays at N. When running wrongly this does not appear.

(4) A tube running rightly will cast a good shadow of the hand on the fluoroscope; running wrongly it will hardly light the fluorescent screen at all, and such faint shadows as it casts will have very bad definition.

It is extremely important that the current should not be run in the wrong direction through the tube, as this causes a black deposit of platinum on the walls, and rapidly decreases its usefulness.

Starting the Tube

In starting the tube it is better to do so gradually. If the tube is started with full power, the regulator will act too vigorously in bringing down the initially high vacuum to the working point. The chemical in E is heated considerably, gives off too much vapor, and the vacuum is carried below the point for which it is set. If the coil has no regulating rheostat, the tube may be gradually started by working the coil intermittently. This may also be done on a battery coil by screwing out the moveable contact until the coil gives a small spark. *Never allow the small platinum D to get heated beyond a dull red.* Should the vacuum be reduced below what is intended, it will, however, automatically rise again to the proper point, the attainment of which is indicated by the resumption of the sparking between A and R, the amount of this sparking depending on the vacuum for which the tube is set, the degree of initial exhaustion, and the amount of gas-producing chemical in E.

Adjustment of the Vacuum

R is adjustable, and is the means of setting the vacuum at any point desired. The nearer the point R is to A the lower the vacuum; the greater this distance, the higher the vacuum. It is well not to make this distance less than one inch on small, and less than 1½ inches on large size coils.

Experience only will enable the operator to set the vacuum at the proper point for all cases which will come up, and there is no point in connection with X-Ray apparatus which will better repay his careful study. A series of exposures on the same subject, with all conditions alike, except the degree of exhaustion of the tube, will afford him most valuable information.

To Prevent Blacking

All coils give a certain amount of reversal current which will pass through the tube if the vacuum is too low; reversal means blackening, and blackening ruins the tube. The reversal effect can be minimized by putting a gap in series with the coil and tube; that is, run one connection direct from the coil to the tube; break the other connection between the coil and the tube by an air space. A simple method of doing this is to make any good insulator of proper length, and tie the wire from the coil and the wire from the tube to opposite ends, allowing

the current to jump from one to the other. *When the induction coil is run on the 110 volt circuit the reversal discharge is always sufficiently great to pass through the tube, and it is consequently essential that a spark gap be used in series with it equal in length to ten per cent., of the total rating of the coil.*

Limit of Safety

Once properly connected and started the current through the tube may be increased to the limit of the regulating power of the tube, which is reached when the sparking entirely ceases between A and R. When this point is passed the tube should be carefully watched.

It is best not to run the tube for any length of time if sparks or brushing will not pass over the spark gap, as the vacuum may be reduced too low and the platinum anode is liable to be punctured.

Never lower the vacuum in the main tube so far that a purple color is seen about the cathode. Should this appear the coil must be immediately stopped to allow the vacuum to recover.

Puncturing

Do not allow the wires from the coil to come near the bulbs, as punctures are liable to result.

A Final Word of Advice

Make yourself thoroughly familiar with the theory of the tube. In the hands of one who understands it it is a most flexible piece of apparatus, easily adapted to his various requirements, and very little likely to be damaged by use. To one who does not, it is a delicate and somewhat intricate affair, quite easily injured.

For short exposures and radiographs, through difficult parts of the body, use coils giving a heavy spark. Energy must be used to produce powerful X-Rays.

Special Advantages of the Queen Self Regulating X-Ray Tube to the Surgeon.

Control of the Penetrating Power of the X-Rays

The fact that the Queen Self-Regulating Tube maintains its vacuum automatically is by no means the most important consideration that recommends it to the surgeon. What is of more importance is the ability which it gives him to vary the vacuum—and hence the penetrating power of the rays—to meet the requirements of various classes of work. The importance of this point cannot be too much enlarged upon, and we feel that the great majority of X-Ray operators who have experienced imperfect results or even total failures have not, in many cases, sufficiently appreciated the causes of their trouble. In simple cases the ability to regulate the vacuum very much facilitates the work, and produces better results; in really difficult cases, such as the detection and location of renal calculi, a slight variation of the vacuum makes all the difference between success and failure. Dr. C. L. Leonard has succeeded repeatedly in performing

this difficult operation, and gives it as his opinion that it is only possible with the Self-Regulating Tube, or one that is attached during the exposure to a mercurial pump so that its vacuum can be maintained at the required point. The advantages of the Self-Regulating Tube over such a costly and difficult method are obvious.

What is a Radiograph

An X-Ray picture is essentially a shadow picture, the details of which are due to the inequalities in density of the various parts of the subject, the penetrability of materials by the X-Ray being approximately in inverse proportion to their densities. It is strong contrasts in density which makes an easy X-Ray subject, and the lack of them which makes a difficult one. It is not difficult, for example, to make a radiograph of the hand, because the rays which penetrate the bones and flesh together have a path of much greater density than those which penetrate the flesh alone, causing a pronounced shadow of the bones on the plate or screen. The hip, on the other hand, presents no such contrasts of density ; whether the rays go through both the muscle and bone, or though the muscle alone, the total amount of dense material in their path is large, and not much larger in the former than in the latter case. The difficulty in this case is not on account of the total density, for it is easy to light up a fluoroscope or fully expose a photographic plate through the hip of a large subject. It is the detection of the relatively slight difference in density that makes the case a difficult one.

Relation Between Degree of Exhaustion and Penetrating Power, Etc.

As already stated the degree of exhaustion greatly affects the quality of the X-Rays in their penetrating power, etc. A great number of experimenters in this country and abroad have demonstrated the following points in this connection :

(1) X-Rays from a high vacuum tube have greater penetrating power than those from a low vacuum tube.

(2) For use with the fluoroscope a relatively high vacuum will give the best result.

(3) For making radiographs a relatively low vacuum will give the best result.

(4) For differentiating foreign bodies, diseased tissues, or bones which, on account of their nature or position do not present strong contrasts in density, the vacuum should be as low as possible to permit of penetration.

(5) For differentiating very dense foreign bodies, such as pieces of metal, from dense and bony tissue, a relatively high vacuum tube must be used to get the best results.

Applying the above general considerations to some examples, the following directions may be given :

Hints on Proper Vacuum for Some Selected Cases

To make a radiograph of the hand or arm the vacuum should be set so low that the bones will appear very black in the fluoroscope. It will then be found that the resulting radiograph shows sharp detail and strong contrasts between the bones and flesh, brings out the larger tendons and cellular structure of the bone, and does not require more than one-third the exposure necessary to produce an inferior result with the vacuum that would be proper for examining the hand with the fluoroscope.

To make a radiograph of the hand or arm for locating a dense foreign body, such as a bullet, use higher vacuum, or the radiograph may not show contrast between the foreign body and a bone.

To make a radiograph of a foreign body in the eye a relatively high vacuum will have to be used, as the foreign body will usually be a dense one, such as a chip of metal or glass, and must be distinguished from the surrounding bone.

To make a radiograph of bones of the pelvis, thorax, or shoulder, use a vacuum somewhat higher than would be required for the arm.

To make fluoroscopic examinations the vacuum should always be higher than for a radiograph of the same subject, it must be varied however for different cases. Thus, a bullet is most readily seen with a high vacuum fluorescence, while the heart or an aneurism of the aorta is best observed by rays from a moderately low vacuum.

X-Ray Dermatitis.

X-Ray burns are liable to result from any prolonged exposure unless the subject is at a long distance from the tube and are more liable to result from a low vacuum tube than from a high vacuum tube. They may be entirely avoided by interposing a card-board screen covered with gold foil between the tube and the subject provided the foil is connected by wire to some good conductor, such as gas or water pipe.

Price List.

5775. The Queen Self-Regulating X-Ray Tube, large size, with extra heavy platinum for use with coils giving very heavy discharge **$18 00**

5776. The Queen Self-Regulating X-Ray Tube, standard size for all ordinary work **15 00**

5780. The Queen Self-Regulating Double Focus Tube for Tesla or Thompson coils. This tube has the two cathodes at right angles to each other and the two bundles of cathode rays impinge on the same side of a heavy platinum anti-cathode, thus giving better definition than the usual form in which the X-Rays originate on both sides of a platinum wedge **18 00**

Some Opinions

of

THE QUEEN

SELF-REGULATING

X-RAY TUBE

Physik. Institut
d Univers. Würzburg.

Würzburg 29 Oktober 97

Herrn Queen & Co. Philadelphia.

Sehr geehrter Herr!

Für die meinem Institut geschenkte X. Röhre sage ich Ihnen meinen besten Dank. Dieselbe hat sich bis jetzt sehr gut bewährt, und ich finde das von Ihnen angewendete Princip zur Regulirung des Vacuums besonders sinnreich. Die Bilder würden noch bedeutend schärfer ausfallen wenn das Platinblech der Kathode vollständig eben und polirt wäre. Ich ersuche Sie mir mitzutheilen zu welchem Preis ich Ihre Röhren erhalten könnte.

Hochachtungsvoll.

Prof. Dr. W. C. Röntgen.

TRANSLATION.

MESSRS. QUEEN & Co., Philadelphia.

GENTLEMEN:

I beg to thank you for the X-ray tube presented to my laboratory. It has worked very satisfactorily, and I find the principle you have applied to the regulation of the vacuum especially ingenious. The images would be even sharper if the platinum plate of the cathode were absolutely plane and polished. Please let me know at what price you can furnish me these tubes.

Yours truly,

PROF. DR. W. C. ROENTGEN.

THE UNIVERSITY,
GLASGOW.

March 18th '98

Dear Sirs,

I have too long delayed writing to thank you for your kindness in presenting to me your X-Ray tube, which I received in November.

I have been prevented until a few days ago from getting a thorough trial of it in my laboratory. We have now had it in action and find it most satisfactory. I wish I had had it all the preceding winter, when it would have saved us a world of trouble in heating the bulb of an ordinary X-Ray tube with a Bunsen burner to prevent it from failing or to restore it when it had failed, in a long series of experiments on electrical effects of X-rays incident on metals, or passing through air in the neighbourhood of metals.

With hearty thanks, I remain

Yours very truly,
Kelvin

Messrs Queen & Co.
Philadelphia.

UNIVERSITY OF PENNSYLVANIA.

Department of Physics.

PHILADELPHIA, April 16, 1897.

Gentlemen:—Your new automatic X-Ray Tube which I have been using for the last week or more has certainly proved itself most satisfactory. I have never had the least trouble with the automatic adjusting attachment, the vacuum remaining constant during an exposure of whatever degree desired. I regard the Queen self-regulating attachment as the greatest improvement which has been made in X-Ray tubes since the introduction of the "focus tube." Every one who has done radiographic work knows that the hip-joint is perhaps the most difficult part of the human anatomy to produce a good picture of. Until the last week I never have gotton a really good hip with a less exposure than ten or fifteen minutes. The last trials were made with the new tube, one with an exposure of three minutes, and the other with an exposure of one minute. The latter is excellent, and the former is the best I have yet seen. I shall take pleasure in sending you a copy of one of these.

Congratulating you on the results of your efforts at advancement,

I am, very sincerely,

ARTHUR W. GOODSPEED.

UNIVERSITY OF PENNSYLVANIA.

THE COLLEGE.

Department of Physics.

PHILADELPHIA, March 6, 1899.

Gentlemen:—Nearly two years ago, when I first began to use your "new automatic X-Ray Tube," I wrote you that with a week's experience it had certainly proved itself most satisfactory. In further commendation of your automatic tube I am pleased to state that I have now, after two years, the same tube and though having been much used from time to time during that period, it is now in excellent condition and nearly as efficient as when first tested.

Since April, 1897 you have furnished me two other automatic tubes each somewhat of an improvement over the first, and these three tubes have done all my work, both experimental and practical. At no time and under no circumstances has either one of them refused to operate with entire satisfaction.

Very sincerely,

ARTHUR W. GOODSPEED.

THE PHILADELPHIA POLYCLINIC AND COLLEGE FOR GRADUATES IN MEDICINE.

PHILADELPHIA, PA., July 13, 1897.

Gentlemen:—In response to your note of inquiry of the 9th instant, would say: I have had one of your new Self-regulating X-Ray tubes in constant use for the past ten or twelve weeks.

Acting on a suggestion of yours, in no way to spare the tube, I have invariably used it with open secondary spark gap on 10 inch coil, sending 20 volts at eight amperes through the primary, regulating the tube entirely by self-regulating device attached to the bulb. I believe the tube to be as good to-day as when I first tried it, this would almost be sufficient recommendation in itself, as you can attest to my laboratory being an exceedingly active one. In respect to the penetration and sharpness of the shadows cast, the tube entirely fulfills requirements. As an example of its efficiency, I succeeded in getting an admirable portrayal of a hip-joint of a man weighing 280 lbs., in five minutes. I can unequivocally endorse the tube as being beyond all peradventure the best and longest-lived of all the tubes I have ever worked with or of which I have any knowledge.

It is a great pleasure to be able to give you my sincere endorsement for your invention. You have done much to advance and enlighten the labors of the workers in the X-Ray field. I have the honor, with much esteem to be,

Your obedient servant,

M. J. STERN,

Prof. of Operative and Clinical Surg., Director of Laboratories.

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490 FOURTH ST., BROOKLYN, N. Y., June 16, 1897.

Gentlemen:—The adjustable vacuum tube you made for me with extra large and heavy platinum is in every way satisfactory. I can now use the full power of my coil, and I think the tube in its present perfected form leaves nothing to be desired.

Enclosed please find check in payment.

Yours very truly,

FRANK A. PERRET.

WAR DEPARTMENT.

Surgeon General's Office, U. S. Army Medical Museum and Library.

WASHINGTON, D. C., July 22, 1897.

Gentlemen:—The Self-regulating X-Ray Tube referred to in your letter of the 20th inst. has been used at this museum by Dr. Wm. M. Gray, microscopist, who reports that it has given good satisfaction; that the vacuum is under perfect control and that the tube gives a uniform steady light with either short or prolonged exposures, and he pronounces it the most satisfactory tube thus far tried.

Very respectfully,

D. L. HUNTINGDON,

Deputy Surgeon General, U. S. Army.

BATTLE CREEK SANITARIUM.

BATTLE CREEK, MICH., July 13, 1897.

Gentlemen:—Yours of the 9th duly received. I have referred the matter to our electrician, who has charge of our X-Ray apparatus, and he informs me that he is well pleased with the tube and regulating device which we received from you. He states that he has been able to get better results from the tube than from any other which he has ever tried in connection with our large static machine.

Yours truly,

J. H. KELLOGG, M. D.

WILLOW GROVE PARK.

MONTGOMERY COUNTY, PA., July 14, 1897.

Gentlemen:—We have two of your Self-regulating X-Ray Tubes on hand in our X-Ray exhibit at above park, one in use and the other ready in case of accident. The one now in use has given and continued to give every satisfaction, both to me and my audiences. Your regulating device is the finest I have seen, I cannot praise it too highly. Since using your Self-regulating I have had no bother in getting perfect and instant rays, surprising many of my audiences.

Yours always sincerely,

EDWIN M. VOIGT,

X-Ray Exhibit, Willow Grove Park.

ARCHITECT'S OFFICE, U. S. CAPITOL.

WASHINGTON, D. C., July 12, 1897.

Dear Sirs:—In reply to yours of the 9th, I beg to state that the large adjustable vacuum X-Ray Tube furnished for my use has really exceeded my expectations in its performance. During the past three weeks it has been in daily use in exhibitions given to Members of Congress and Senators and in the course of these exhibitions, has been called upon to show every interesting action of the rays, both in relation to the human body and in the penetration of various substances in ways calculated to interest uninformed persons. These various features required a tube with a wide range of vacuum. I was able to do everything with the tube sent, by simple adjustments of the spark gap. Perhaps the most interesting part of the work has been the location of a bullet in the leg of Senator Faulkner, in a position entirely removed from the supposed location, and the location of a bullet in the chest of a person sent to me for examination. The vacuum required for these two examinations was readily adjusted to the proper degree. You can judge that I am perfectly satisfied with the tube in every respect. I feel that I ought to give testimony to the accurate concentration of the cathode rays on the platinum anode, by which such splendid definition is secured. It must certainly mean that great care is exercised in placing the electrodes at the proper distance.

Yours very truly,

ELLIOTT WOODS.

DEMOPOLIS, ALA., July 14, 1897.

Gentlemen:—I recently bought of you one of your small Self-regulating Tubes, so far the tube has given perfect satisfaction and I am much pleased with it. I have not been able to get such good results from other tubes.

Yours truly,

J. R. GOODLOE, M. D.

VALPARAISO, IND., July 14, 1897.

Dear Sirs:—Yours at hand. In reply would say that the Self-regulating Tube has given excellent satisfaction.

Yours truly,

F. A. REECE.

STANDARD UNDERGROUND CABLE CO.

PITTSBURG, PA., July 27, 1897.

Gentlemen:—Replying to your favor of July 20th, I would say that we have had occasion to use but one of your new Self-regulating X-Ray Tubes, and it has given us excellent satisfaction from the start. I used it in my lecture before the Engineers' Society of Western Pennsylvania, and it gave most satisfactory results. Since then I have used it occasionally in our factory, and have never had any trouble in showing the movements of the heart and diaphram. I consider it by far the best tube I have used so far.

Very truly yours,

HENRY W. FISHER,

Electrician.

MAURICE I. ROSENTHAL, M. D.

Physician and Surgeon to St. Joseph's Hospital.

FORT WAYNE, IND., July 25, 1897.

Dear Sirs:—Enclosed please find check for thirty dollars ($30.00) for X-Ray tubes, our intention was to keep only one of them, but since they give such excellent satisfaction decided to keep both.

Respectfully yours,

MAURICE I. ROSENTHAL.

ELECTRICAL CASINO.

ASBURY PARK, July 22, 1897.

Gentlemen:—Your Self-regulating Tubes were received in good condition and I am pleased to inform you that after giving them a severe test I am able to pronounce them highly satisfactory. The test referred to was the location of a twenty-five cent piece, which had been accidently swallowed, in a man's stomach. It was made in presence of Dr. W. F. Bryane and several reputable citizens and newspaper reporters of this city.

Yours very respectfully,

BENJ. BEERWALD, MGR.

CHICAGO, ILL., July 12, 1897.

Dear Sirs:—Replying to your communication of the 9th instant, relative to the Queen Self-regulating X-Ray Tube, would state that the writer has tried the tube under various conditions, and so far as he has observed it has been self-regulating under all conditions and we look upon it as without question the most desirable commercial tube that his yet been offered.

Respectfully,

CENTRAL ELECTRIC CO.,
CHAS. G. BURTON.

CINCINNATI, OHIO, July 2[illegible], 1897.

Gentlemen:—The Tube is O. K. and one of the best I have had. I shall order another very soon and pay for the one I now have.

Expensive things are as a rule the best.

Yours,

MERRILL RICKETTS, M. D.

OTTAWA, ILL., July 12, 1897.

Gentlemen:—Replying to your letter of the 9th inst, addressed to Jordan & Hamilton, I am pleased to inform you that I have used the tube purchased of you with great satisfaction. The vacuum seems to be under entire control within all reasonable limits. The regulating device is very simple, and so far I have found it to be entirely reliable.

Yours truly,

C. H. HAMILTON.

PENNSYLVANIA STATE COLLEGE.

STATE COLLEGE, PA., July 22, 1897.

Gentlemen:—The new Self-regulating X-Ray Tube, about which you inquire in your letter of the 9th instant, was received just as I was preparing to leave for vacation, and I used it but once. It worked excellently, giving very strong effect and unusually good definition. The self-regulating device is a great improvement, and works well.

Yours very truly,

I. THORNTON OSMOND, M. S., M. A.

MEMPHIS, TENN., July 23, 1897.

Gentlemen:—In answer to your communication of the 20th instant, I wish to say that I have had the Self-regulating Tube in use ever since receiving it, and am much pleased with its work. The self-regulating device is ingenious, life saving to the tube and better in its high vacuum effect than any tube I have used before, and I have used many.

Yours truly,

M. GOLTMAN, M. D.

CASE SCHOOL OF APPLIED SCIENCE.

PHYSICAL LABORATORY.

CLEVELAND, OHIO, August 3, 1897.

Gentlemen:—The Self-regulating X-Ray Tube which I purchased May 15th has been used much in all kinds of work, as I have repeatedly photographed every part of the adult human subject with satisfactory results. It has worked well for a much longer period than any other tube I have used. Last evening I used it on a full grown man and exhibited to a dozen people at once, using an open screen, the bones in all parts of the body, the liver and other organs, and the action of the diaphragm and the heart beats were seen very distinctly.

As the tube still works so well, I believe the self-regulating feature is a success. I will, in a day or two, send you some photographs obtained with this tube.

Yours very truly,

DAYTON C. MILLER.

THE GENERAL ELECTRIC CO., LIMITED,

OF LONDON AND MANCHESTER.

MANCHESTER, July 30, 1897.

Gentlemen:—Replying to your inquiry, we beg to say that we received the special X-Ray tube all right, and have been using it with the utmost satisfaction, obtaining very good results. In a short time we hope to test it in a more thorough manner and shall then write you again.

Yours truly,

GENERAL ELECTRIC CO., LIMITED.

BOSTON, October 23, 1897.

Gentlemen:—Your Self-Regulating X-Ray Tube, large size, was used for a week in July, and has been thoroughly tested in this laboratory during the past three weeks. The work in which the tube is used requires generation of rays of uniform intensity for several hours together. We formerly used tubes without any device for regulating vacuum, and were frequently troubled by the vacuum increasing so much during an observation, that work had to be stopped. By your regulating device we have been able to get just the vacuum we desired. Your tube has maintained this vacuum for the last three weeks, and has caused no trouble at all, for it can take care of itself.

Yours very truly,

H. P. BOWDITCH, M. D.,

Professor Physiology, Harvard Medical School.

BROOKLYN X-RAY STUDIO.

BROOKLYN, July 20, 1897.

Gentlemen:—In answer to your letter of inquiry, relative to our opinion, and results obtained, with the use of your Self-Regulating Tube, would state we have used the Self-regulating Tubes for past three months with excellent results, and find, with proper adjustment of vacuum, the penetration is greater than with any tube we have used. In fluroscopic work it is very fine; also find (with proper adjustment of vacuum) in taking radiographs to locate foreign bodies, or show condition of the bones, the time of exposure is reduced one-half. Our tubes cause no trouble, when worked properly, and have given us satisfactory results up to date.

Very respectfully,

J. D. JAMES, *Manager.*

STATE NORMAL SCHOOL.

ONEONTA, N. Y., July 14, 1897.

Dear Sirs:—I consider your Self-regulating Crookes' Tube to be the most marked improvement that has been made in apparatus for the production of the Röntgen ray since the discovery of this energy was first announced. It maintains a given degree of vacuum *perfectly* and thus frees the operator from much anxiety and annoyance. This form of tube will in the future, I believe, be widely adopted.

Yours respectfully,

HOWARD LYON,
Dept. of Phys. and Chem

INDIANAPOLIS, IND., July 13, 1897.

Dear Sirs:—In reply will say that I am more than pleased with the tube and intend getting another to take with me on a South American tour.

Yours truly,

R. R. BENNETT.

ALLENTOWN, PA., May 12, 1897.

Gentlemen:—Have tested your new Automatic Self-regulating X-Ray Tube, it works to perfection, think it is the best tube in the market.

Yours sincerely,

H. H. C. SMITH, E. E.

BUFFALO, N. Y., July 12, 1897.

Dear Sirs:—Enclosed find check for $15.00, in payment of your Self-regulating X-Ray Tube. I have not had occasion to use it very often, but it was very satisfactory the few times I used it.

Yours sincerely,

DR. E. J. MEYER.

SOUTHWESTERN UNIVERSITY.

GEORGETOWN, TEXAS, July 26, 1897.

Dear Sirs:—Having in my posession X-Ray tubes from four other manufacturers, I some months since made a comparative test of the best of these and of your adjustable vacuum tube.

This test was made by ascertaining the greatest distance at which the radiations from each could be detected by a calcium tungstate screen. This distance with the former varied from 10 to 41 ft. while with your tube it was 71 feet.

Assuming that the law of inverse squares holds true in the case of X-Rays, the above tests show your tube to be three times as efficient as the best that I have thus far obtained from other makers.

It is readily adjusted to any desired vacuum, and remains quite constant.

Yours truly,

R. S. HYER.

PHILADELPHIA, PA., July 31st, 1897.

Gentlemen:—In reply to your inquiry I beg to say that I have been using one of your Self-regulating X-Ray Tubes since the first of April and during the *four months elapsed since then have run it about ½ hour each day.* In all this time it has proven thoroughly satisfactory, as it regulates and controls its vacuum readily, gives powerful X-Rays and in every way fulfils the claims you make for it.

Yours very truly,

DR. D. ALEXIS MYERS, M. D.,
2937 Girard Avenue.

CHICAGO, ILL., October 15, 1897.

Gentlemen:—After having witnessed the operation of your automatically adjustable Röntgen ray tube, I take the pleasure in voluntarily giving you a testimonial. Long experience in the operation and design of tubes has convinced me that both for sciagraphic and fluoroscopic work it is necessary to have a tube which has a considerable range of adjustment of the vacuum, and also possesses some means of maintaining any desired vacuum.

Your shunted tubes seem to meet both these requirements. I have never seen more powerful rays from any tube, nor have I been able to adjust a tube with anything like the ease with which I can yours.

Very truly yours,
W. M. STINE,
Armor Institute of Technology.

UNIVERSITY OF TENNESSEE, KNOXVILLE,
OFFICE OF THE PRESIDENT.

NASHVILLE, TENN., August 21, 1897.

Dear Sirs:—In regard to the Queen Tube which we have been using, would say that we are still using the first tube we purchased of you more than two months ago. Being for exhibition purposes, the wear is nearly constant with heavy current. The tube shows no wear, giving excellent results.

Yours very truly,
CHARLES E. FERRIS.

FALL RIVER, MASS., August 16, 1897.

Gentlemen:—I received the tube all right, and it is a beauty.

Very faithfully yours,
JOHN BEATTIE, JR.

BROOKLYN, N. Y., July 21, 1897.

Dear Sirs:—It gives me great pleasure to testify to the satisfaction which the Self-regulating tube has given me ever since I obtained it. The rapidity with which rays of any desired penetration can be produced, and the practically unlimited duration of time for which they may be maintained, transforms irritating uncertainties into experiments of precision.

Very truly,
SAMUEL SHELDON, A. M., PH. D.
Prof. Physics and Elec. Eng., Polytechnic Inst.

CRANFORD, N. J., July 20, 1897.

Gentlemen:—Your letter received, and in reply would state that so far as I have used your Crookes' Tube, I have found it satisfactory. It has never failed to generate and give a good steady light, as long as I have desired to use it for work. I will say that it is the first tube I have been able to place any real dependence upon, that it would be ready for work when I wanted it.

Yours truly,
W. C. ALLEN, M. D.

SURGICAL INFIRMARY.

ABERDEEN, MISS., August 17, 1897.

Gentlemen:—As per my promise, I write to advise you that we have our X-Ray working, and have given your tube a thorough test, and must say that it more than comes up to our fondest expectations. We have tried most every make, but the results obtained from the Queen Tube excel, by far, all others.

Very truly yours,
WALLON S. GREEN, M. D.

KENTUCKY SCHOOL OF MEDICINE.

LOUISVILLE, KY., December 27, 1897.

Gentlemen:—Some time ago you asked me to tell you what I thought of your "Self-regulating Vacuum Tube," I haven't done it yet but will do so now. It gives me great pleasure to say what I think about this tube and the vacuum adjusting device.

In the first place the workmanship of the tube in general is first class, graceful in every detail, which, while not absolutely essential to the proper working of the tube, adds beauty to an X-Ray instrument.

In the second place, your manner of placing the concave electrodes, braced in glass stems rendering them thoroughly permanent makes your tube invaluable. Another point equally as valuable is the great distance between the connections which entirely overcomes the danger of a puncture. The last two points just mentioned alone makes your tube a most desirable tube, for, before receiving your tube, I constantly had serious trouble with sparking across my tube or from the concave discs falling over in contact with the tube wall, from lack of suport, and permanently disabling my tube. This danger does not exist with your tube.

Thirdly, I will speak of the automatic vacuum adjuster. To say that it works *all right* does not express it, yet an operator, who has gone through the *ups* and *downs* of heating his tube with a Bunsen burner or alcohol flame constantly while making an exposure, and right in the midst of a most important exposure has had the tube collapse and explode like a cannon, would be pleased, *yes, delighted*, if he could say (in reference to his vacuum,) "It works all right." The "too high vacuum" *used to be* the bane of my X-Ray life, while now it is a delightful pleasure to watch the current brushing and leaping by sparks across *in the direction of least resistance* until my Crooks' vacuum becomes beautifully brilliant.

This is my candid opinion of your tube and you may use it, or any part of it in your circular if you so desire.

J. T. DUNN, M. D.

Demonstrator of Operative and X-Ray Surgery in the Ky. School of Medicine.

PIERCE & STEVENS.

BUFFALO, N. Y., February 28, 1898.

Gentlemen:—Enclosed please find remittance to pay for X-Ray tube just received.

In working this tube after my lecture Friday evening, it gave the best results, and compared *more than favorably* with other makes. One gentleman who saw it in operation wishes a duplicate, and you will please send to Dr. Lee H. Smith, 663 Main St., Buffalo, N. Y., one X-Ray Tube, large size, and same as one sent to me.

Yours truly,

E. B. STEVENS.

KANSAS STATE AGRICULTURAL COLLEGE.

MANHATTAN, KAS., March 29, 1898.

Gentlemen:—The Self-regulating X-Ray Tube received of you last September has proved entirely satisfactory. It is powerful in action when taking full eight inch spark. It regulates perfectly and shows no sign of failing.

Yours truly,

E. R. NICHOLS.

INVALIDS' HOTEL AND SURGICAL INSTITUTE.

BUFFALO, N. Y., March 29, 1898.

Gentlemen:—We have your report in regard to the Self-regulating X-Ray Tube. It is by far the best instrument of the kind that has ever been attached to our machine. We have had great trouble with the static machine in order to obtain a good X-Ray Tube that would last; yours seems to fill the bill. We will report again in a month's time as to the work done with it; but so far, we are more than pleased with the apparatus. We are,

Very truly yours,

LEE H. SMITH, *Vice-President,*

World's Dispensary Medical Association.

MANHATTAN SPIRIT CO.

BUFFALO, N. Y., March 15, 1898.

Gentlemen:—In reply to yours of the 11th. The large Self-regulating X-Ray Tube bought of you February 21st, is *very* satisfactory. Its the best X-Ray tube I've yet seen.

Yours very truly,

EDGAR B. STEVENS.

COOK ACADEMY.

MONTOUR FALLS, N. Y., March 14, 1898.

Gentlemen:—The Self-regulating X-Ray Tube purchased of you some months ago is giving the best of satisfaction. For ordinary work I seldom use more than a 6 inch spark, the tube bringing out all the detail needed for fluoroscopic and photographic requirements. With a 10 inch spark, the tube does wonders. Short exposure, well defined negatives, uniform vacuum and ease of operation, explain why, with eight other tubes available in the laboratory, all but the "Queen" are having a prolonged resting spell.

Yours truly,

J. E. WOODLAND.

HOSPITAL OF THE P. E. CHURCH.

PHILADELPHIA, March 18, 1898.

Dear Sirs:—Your communication in reference to Self-regulating X-Ray Tube, furnished by yourselves received. In reply, we have been using your Self-regulating Tube since October, 1897 and have found it to work very satisfactory.

Sincerely yours,

HENRY SYKES.

OFFICE OF MEDICAL OFFICER IN COMMAND,
MARINE-HOSPITAL SERVICE.

PORT OF BOSTON, MASS., March 12, 1898.

Gentlemen:—The X-Ray Tube gives entire satisfaction.

Respectfully yours,

H. W. AUSTIN, *Surgeon, U. S. M. H. S.*

In Command of Hospital.

DR. J. C. HUBBARD.

HOLYOKE, MASS., March 18, 1898.

Gentlemen:—Replying to your enquiry of the 14th. We have used your Self-regulating X-Ray Tubes exclusively on our 12 inch coil since November last. They have given us no trouble and the results have been entirely satisfactory.

Very truly yours,
J. C. HUBBARD,
for Holyoke City Hospital.

ST. LOUIS ELECTRICAL SUPPLY CO.

ST. LOUIS, March 18, 1898.

Gentlemen:—The writer of this has been using a number of your Self-regulating X-Ray Tubes and they have given the very best of satisfaction, both on the static machines and direct current coils and can highly recommend them to every user of same.

Yours truly,
E. RUEBEL, *President,*
St. Louis Electrical Supply Co.

THOS. P. HINMAN, D. D. S.

ATLANTA, GA., March 18, 1898.

Gentlemen:—Your letter of March 14th came duly to hand. You ask me about the Self-regulating X-Ray Tube furnished me by you in November, 1897.

Allow me to say, that of all the tubes that I have handled, "and I have had several from different manufacturers," nothing has compared even favorably with your production. It has been a source of a great deal of comfort to me, and has been in fairly continuous use ever since it arrived, and is doing work now equal to what it did when it first arrived.

Believe me,

Very truly yours,
THOS. P. HINMAN.

ARKANSAS INDUSTRIAL UNIVERSITY.

FAYETTEVILLE, ARK., March 18, 1898.

Gentlemen:—Replying to your inquiry concerning the Self-regulating X-Ray Tubes, which you furnished to us, I am pleased to report that they are giving entire satisfaction. When once started the tube will run for hours without changing its vacuum, and without attention.

With the ray from this tube, and using the platino-barium-cyanide fluoroscope, we can readily see the actions of the heart, and make out the entire skeleton of a child 12 years old.

Yours very truly,
W. N. GLADSON, *Professor,*
Electrical Engineering Dep't,
Ark. Ind. University.

UNIVERSITY OF VIRGINIA.

March 17, 1898.

Gentlemen:—I have as yet had no occasion to use the tube you sent me, but its reputation is so good that I feel no apprehension about it.

My assistant has used it both with a coil and an influence machine, and reports well of it.

Yours truly,
FRANCIS H. SMITH.

J. N. SCOTT & CO.

KANSAS CITY, MO., March 17, 1898.

Gentlemen:—The Queen Self-regulating Tube which I purchased of you on December 13th has been in use constantly since that time, and it is the best tube I have ever used. My apparatus gives a very large volume of spark, but the the tube you furnished me with the extra large platinum carries it without heating too much. It has a great penetrating power, and at the same time it gives good definition in fluoroscopic examinations and contrasts in radiograph.

Respectfully,

J. N. SCOTT,
Per G. M. D.

THE CLIFTON SPRINGS SANITARIUM COMPANY.

CLIFTON SPRINGS, N. Y., March 25, 1898.

Dear Sirs:—We have used your Self-regulating X-Ray Tube more or less for the last four months, and have found it highly satisfactory each time. It requires considerable experience to get the full benefit of it, and it is only within the last month or two that we have had all the advantage that can be obtained from the self-regulating tube. The entire apparatus has been very satisfactory. Very truly yours,

JOHN A. LICHTY.

UNIVERSITY OF TENNESSEE.

KNOXVILLE, TENN., March 26, 1898.

Sirs:—In reply to your letter of the 22d inst., I will say that we have used eight of your Self-regulating X-Ray Tubes, both for sciagraph and for fluoroscope exhibitions. We have used four other kinds of tubes by as many different makers, but have found your tube to be the most satisfactory that we have tried.

Yours truly,

CHAS. A. PERKINS.

H. S. SANDS ELECTRIC & MFG. CO.

WHEELING, W. VA., March 28, 1898.

Gentlemen:—Yours of the 26th, asking us how we liked your Self-regulating X-Ray Tube, received. In reply to same will say that this tube gives good results, and are very much pleased with same, although it is too small for our present apparatus. Yours very truly,

H. S. SANDS.

THE ELECTRIC SUPPLY AND MANUFACTURING CO.

CLEVELAND, O., March 22, 1898.

Gentlemen:—In regard to your Self-regulating X-Ray Tube, would say that it has been entirely satisfactory, and far ahead of anything that we have yet had.

Yours truly,

H. WHITFORD JONES, *Manager*,
The Electric Supply & Mfg. Co.

RUDOLPH SCHMIDT & CO.

ROCHESTER, N. Y., March 21, 1898.

Dear Sirs:—We have used two of your Self-regulating X-Ray Tubes since last November on a 10-inch coil, and find them to work more steadily than any tube had previously. We are with respect,

Yours truly,

RUDOLPH SCHMIDT & CO.
W. W. K.

DR. AUG. SCHMIDT.

ST. LOUIS, MO., March 31, 1898.

Gentlemen:—The Self-regulating X-Ray Tubes obtained from you give the greatest satisfaction. The one I have in use now I have been using constantly for the past six months, and is at this time as good as when first used. I have used all of the many kinds in the market, none, however, were as durable, or gave such satisfaction as your self-regulating. I use the X-Rays daily in my practice, and it is a pleasure to have a reliable tube after having had so many and expensive disappointments with the others.

Very truly yours,

AUG. SCHMIDT, M. D.

WARNER BROTHERS COMPANY.

BRIDGEPORT, CONN., March 29, 1898.

Dear Sirs:—Answering yours of March 26th, would say that the writer has gotten two of your Self-regulating Tubes from you, one of which he has used constantly personally, the other of which he sold to the local hospital in connection with other apparatus which he got for them. Would say in regard to same that they have both been very satisfactory. The only suggestion which he can make would be to improve the inner branch of the tube so as to avoid puncturing, if possible, which, from the last two that you sent me, it seems as though you had done. I have had splendid success with both tubes and they have both done very fine work.

Yours truly,

T. FISH.

MARENGO COUNTY HEALTH OFFICE,

J. R. GOODLOE, M. D.

DEMOPOLIS, ALA., April 3, 1898.

Gentlemen:—Yours of March 26th to hand. In reply to which I take pleasure in stating both of your Self-regulating X-Ray Tubes have given the best of satisfaction, they have had longer life than any tubes I have yet had, and were still working nicely when I last used them.

Yours truly,

J. R. GOODLOE.

COMMONWEALTH OF PENNSYLVANIA,

STATE BOARD OF HEALTH.

April 4, 1898.

Dear Sirs:—The Germantown Hospital was furnished with an "X-Ray" apparatus in December, 1897, by you and since that time the outfit has been used a great deal. Except for a few trifling adjustments in the beginning, the apparatus has given great satisfaction; especially the self-regulating vacuum tubes. We shall be glad to exhibit our apparatus to any one thinking of buying an outfit, and can in every way recommend it as exactly suited to clinical purposes.

Very truly,

ROBERT L. PITFIELD, M. D.

MT. ALLISON UNIVERSITY,

CHEMICAL LABORATORY.

SACKVILLE, N. B., May 12, 1898.

Gentlemen:—Your new X-Ray Tube has with us given the greatest satisfaction. We thank you for putting within our reach so effective and beautiful a tube.

Yours truly,

W. W. ANDREWS,

Professor of Chemistry and Experimental Physics.

MASLIN PARK HIGH SCHOOL.

BUFFALO, N. Y., May 2, 1898.

Dear Sirs:—The X-Ray Tube received from you a short time ago is very satisfactory and fully comes up to my expectations. I turned the bill sent over to our principal, Mr. Fosdick, who will see that it receives the proper attention of the school authorities.

Very respectfully,

GEO. M. TURNER.

COLUMBUS, OHIO, May 25, 1898.

Gentlemen:—Please send me at once another of your large Self-regulating X-Ray Tubes.

The one you sent me in October, 1897, has been in daily use ever since it was received, and with the most satisfactory results.

Yours very truly,

L. M. EARLY, M. D.

U. S. ELECTRICAL SUPPLY CO.,

141 E. 25TH ST.

NEW YORK, June 10, 1898.

Gentlemen:—We used one of your tubes at the Electric Exhibition here and it is a wonder. It is perfectly black and emits hardly any light at all, but gives a beautifully clear bright field upon the fluoroscope, although it was in use for eight hours per day for nearly two weeks, during which time we handled nearly 15,000 people every day.

Yours very truly,

U. S. ELECTRICAL SUPPLY CO.,

Per W. J. Clark.

COOK ACADEMY.

MONTOUR FALLS, N. Y., January 9, 1899.

Gentlemen:—Just one year ago lacking a few days, we purchased a large Queen Self-regulating Tube of you. It has been in use all the time and seems to be as good as the day it was first used. We do not expect it to last forever, so you may send us another tube to lay by for emergency.

J. E. WOODLAND,

Instructor in Physics, Cook Academy.

THE MEDICAL COLLEGE OF ALABAMA,
OFFICE OF THE SECRETARY.

MOBILE, ALABAMA, January 18, 1899.

Gentlemen:—I received the X-Ray Tube in good shape, and I am very much pleased with it. If you sent the bill with the tube it has gone astray, as it has not yet come to hand.

I know that the tube is $15.00, but I do not know how much the express charges were, which you were kind enough to prepay at my request. Please send me the bill at once, and I will immediately remit the amount.

Thanking you for your courtesy,

Yours very truly,
WILLIAM B. PAPE.

260 St. Francis Street.

INDIANA UNIVERSITY,
DEPARTMENT OF PHYSICS.

BLOOMINGTON, IND., February 6, 1899.

Gentlemen:—The X-Ray Tubes purchased of you are the best I have ever tried.

Respectfully,
ARTHUR L. FOLEY.

1930 CHESTNUT STREET.

PHILADELPHIA, PA., March 9, 1899.

Gentlemen:—The following is probably a fair statement of my opinion of the Queen Self-regulating Tube.

The future development of the Roentgen ray as a means of diagnosis, that seems to promise most, is the increase in our power to study the less opaque tissues. They can only be shown by the employment of the less penetrating discharge from a "soft" or low vacuum tube. It is especially difficult to obtain the large volume of Roentgen discharge often required from any tube that can not be lowered from a higher vacuum at will and maintained at the desired point as long as it is required. I have found your Self-regulating Tubes capable of this adjustment. They have made the absolute positive and negative diagnosis of renal calculus possible because the shadow of the kidney can be shown through the tissues surrounding it, and consequently no calculus can escape detection. The chief value of your tube lies in the power of the operator to make it do exactly as he desires whenever he needs it. This makes possible the repetition of exposures under identical conditions at any future time.

Very truly yours,
CHARLES LESTER LEONARD, M. D.

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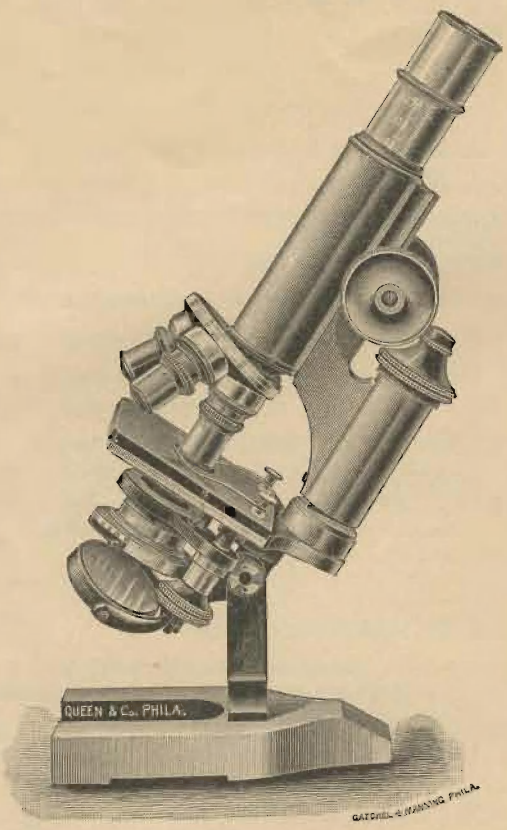

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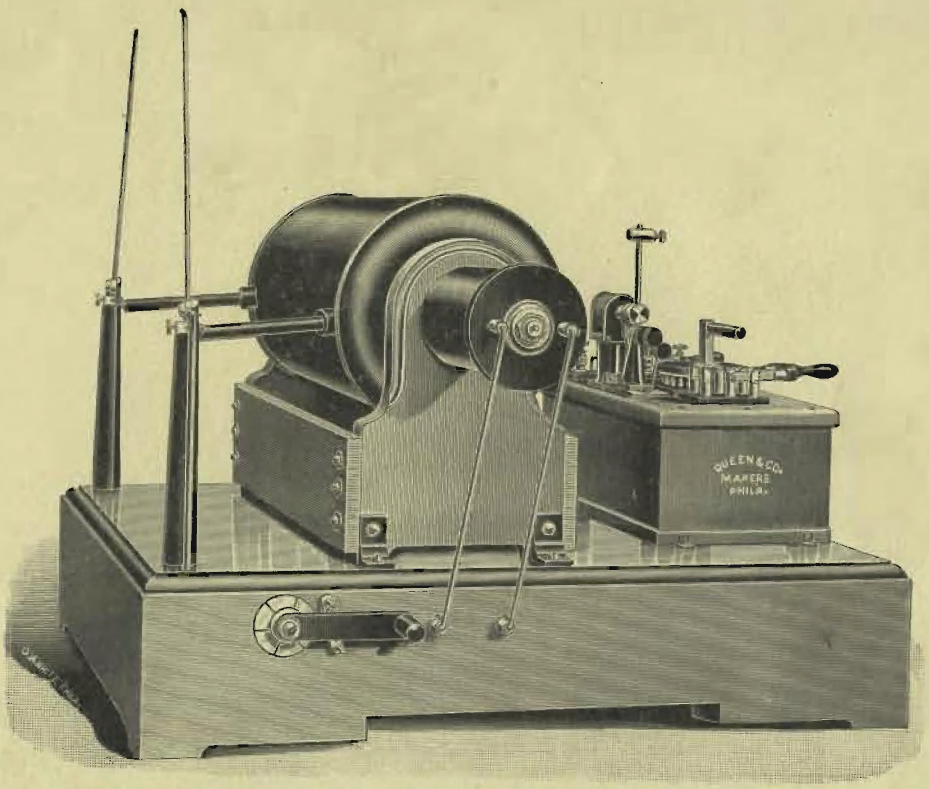

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